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Silvical Characteristics of Slash Pine

(Pinus elliottii, Engelm. var. elliottii)

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Slash pine (Pinus elliottii, Engelm. var. elliottii) (15) is one of the most important pines in the Southeastern United States and one of the two southern pines worked for naval stores. Its range extends from the Coastal Plain of southern South Carolina to central Florida and southeastern Louisiana (fig. 1). The northernmost natural growth of slash pine is believed to be that located in Georgetown County, South Carolina, about latitude $33\frac{1}{2}^{o}$N. South Florida slash pine (Pinus elliottii Engelm. var. densa Little and Dorman) is known only in Florida and has only recently been distinguished as a new botanical variety; its range extends from the lower Florida Keys north to Lake Okeechobee and then in two prongs along both coasts as far north as central Florida. South Florida slash pine (16) can be distinguished from the typical slash pine by its grasslike, almost stemless seedling stage, which resembles longleaf pine, and its heavy wood with wide bands of summerwood. This silvical writeup, however, deals only with typical slash pine.

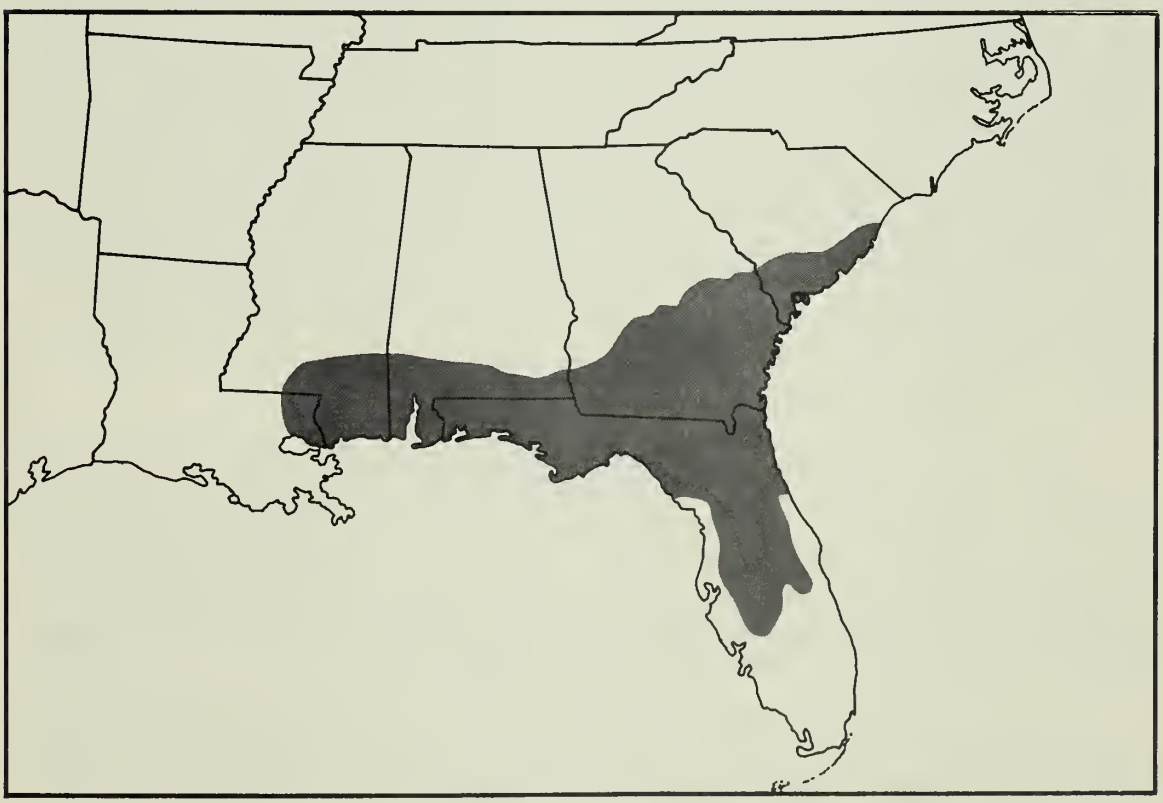

Figure 1.--Botanical range of slash pine (Pinus elliottii Engelm. var. elliottii).

Slash pine is a fast-growing tree, often reaching a height of 80 to 100 feet and a trunk diameter of 30 inches in 60 years (12). The leaves are needle-like, 8 to 12 inches long, and in fascicles of 2 and 3 on the same tree. The stalked mature cones, mostly 2 to 6 inches long, distinguish this species from the sessile-coned loblolly pine with which it may often be confused. Slash pine may occasionally be mistaken for longleaf pine, but the club-like twigs of longleaf pine help to distinguish it from the slender-twigged slash pine. The cinnamon-brown candles of slash pine also help to distinguish it from the silver-white longleaf shoots.

HABITAT CONDITIONS

CLIMATIC

Slash pine grows in the southeastern United States, a region characterized by warm, humid weather, wet summers, and drier falls and springs (25). The annual precipitation averages about 50 inches, 70 percent of which falls during a growing season of 250 days. The average annual temperature is 63°F. with occasional extremes of 106° and 0°.

EDAPHIC AND PHYSIOGRAPHIC

The soils within the natural range of slash pine are many and varied, but as a whole they are sandy, and often underlain with poorly drained hardpans. Hardpans are usually from 18 to 24 inches below the surface. Because of its susceptibility to fire injury in the juvenile stage, slash pine in the flatwoods was confined until recently to the "ponds" or pond margins where ample soil moisture or standing water provided protection. Shallow depressions which store water for part of the year and go dry for the rest are called "ponds" in the flatwoods area. Outside the flatwoods, slash pine occurred most generally in narrow bands along creeks, bays, and other minor drainages. With better fire protection, the species has now spread out between ponds, and many young slash pine stands have become established under sparse longleaf overstories. This expansion has engulfed many more soil types, including some of the sandhills, scrub-oak ridges, and less sandy soils of the Middle Coastal Plain.

Slash pine has made its best growth on pond margin sites. The typical "flatwoods" sites, which include the incompletely drained soils and the hardpan soils, are probably next in productivity. Slash pine stands are least productive on the deep, well-drained pure sands or the poorly drained lands (crawfish flats). However, some of the young plantations on the deep sands have experienced good survival and acceptable initial growth. Timber stands on old fields usually out-produce those on forest sites.

Topography does not vary much within the natural range of slash pine, but even changes in elevation of 1 or 2 feet are often accompanied by a pronounced change in soil condition and site productivity.

BIOTIC

Timber types which include slash pine as an integral member, other than pure stands of slash pine, are longleaf-slash pine, cabbage palmetto-slash pine, slash pine-hardwoods, and slash pine-tupelo. This species is also an associate of seven other forest types where these types fall within the range of slash pine (24). Some of the other important associate species of the above types are red maple (Acer rubrum var. rubrum), red gum (Liquidambar stryaciflua), sweet bay (Magnolia virginiana), loblolly bay (Gordonia lasianthus), tupelo gum (Nyssa aquatica), live oak (Quercus virginiana var. virginiana), and cabbage palmetto (Sabal palmetto). Understory vegetation commonly associated with slash pine includes saw palmetto (Serenoa repens), scrub palmetto (Sabal etonia), tall bush gallberry (Ilex coriacea), low bush gallberry (Ilex glabra), titi (Cliftonia monophylla), and waxmyrtle (Myrica spp.).

The natural range of this species is being extended by plantings, but its northern limit is restricted by the damage incurred in periodic ice storms. Plantings in the Carolina Sandhills, however, date back to 1933 and very little ice damage has been reported. It will also grow in some areas like east Texas, but does not reproduce naturally. Slash pine continues to be planted in considerably greater numbers than any other southern species.

Animal life in the slash type is represented by white tailed deer (Odocoileus virginianus), black bear (Euarctos floridanus), gray squirrel (Sciurus carolinensis), fox squirrel (Sciurus niger), cottontail rabbit (Sylvilagus palustris), and a variety of other wildlife. Among many species of birds, wild turkey (Meleagris gallopavo), dove (Zenaida macroura), and bobwhite quail (Colinus virginianus) make up the greatest part of the game-bird population. Diamondback rattlesnakes (Crotalus adamanteus), coral snakes (Micrurus fulvis), and cottonmouth moccasins (Agkistrodon piscivorus) are the more common poisonous reptiles found in this timber type. But, the most distinctive and widespread associates of slash pine in most areas are scrub cows and razorback woods hogs which have for generations been allowed to run semiwild in the forest.

LIFE HISTORY

SEEDING HABITS

Flowering and Fruiting

The flower buds of slash pine are formed in midsummer, but cannot be recognized until the following winter (23). Staminate strobili are visible about a week before the pistillate strobili. Pollen usually ripens during a 2- or 3-week period between the latter part of January and early March but the time of pollen shedding varies considerably from year to year with weather conditions. The conelets are about $\frac{1}{2}$ inch long at the time of pollen dissemination and lengthen very slowly during the first growing season, seldom more than

½ inch. Cones mature in August or September of the second year, when they should average about 5 inches in length. Seeds ripen in September, and the bulk of seed dispersal occurs in October.

Specific gravity is probably the best criterion for judging seed ripeness of slash pine cones (27, 28). When the specific gravity of freshly picked cones is 0.90 or lower, the seeds are usually ripe, and when the specific gravity drops to about 0.70 the cones begin to open on the tree. If freshly picked slash pine cones float in SAE 20 motor oil, they may be considered mature.

Seed Production

As a rule, slash pine trees seldom bear cones until they are at least 10 years old or more than 4 inches in diameter. However, they do not bear cones in large numbers until they are over 20 years old. Yields of more than 200 cones per tree are not unusual on large trees in a good seed year. Such a crop would amount to more than a pound of seed per tree, or about 15,000 seed (27). Heavy cone crops occur about once every 3 years.

Cone production may be stimulated by crown release, stem injury, or fertilization. In one study of the effect of release, a shelterwood stand of 25 to 35 stems per acre produced more cones 3 years after cutting than the fully stocked, uncut portion of the stand. Partial girdling of 20-year-old slash pine trees increased flower production nearly 100 percent.[1/] In another study normal turpentining practices (bark chipping and acid treatment) resulted in an increase of nearly 50 percent in the production of cones 3 years after the naval stores operation began. Cone production has been almost doubled by the application of 20 to 40 pounds of complete fertilizer to each tree.

Not all of the pollinated flowers survive and grow to maturity; ordinarily, less than half of them produce mature cones that contribute to the seed crop. Insects, rodents, disease, and weather make up the major factors that account for this production loss. Beetles and cone moths (Dioryctria sp.) destroy seeds and other cone tissues by their larval feeding, but their habits and the extent of damage throughout the range of slash pine are yet to be determined.

The gray squirrel and the fox squirrel often cut down many of the cones just before they mature, but longleaf cones ordinarily suffer more rodent damage than slash pine. A common disease in some sections of the belt is the pine cone rust (Cronartium strobilinum), which can reduce production considerably (14).

Weather conditions exert their greatest influence at the time female flowers are receptive; after pollination is complete, these conditions play a very small part in the production of seed within the natural range of slash pine.

1/ Hoekstra, P. E., and François Mergen. Experimental Induction of female flowers in young slash pine. Publication pending in Journal of Forestry.

Seed Dissemination

The earliest recorded slash pine seedfall in a 5-year study in north Florida was during the first week of September. More than 75 percent of the total seed for these 5 years fell during the month of October, but a few seed fell as late as March. The quality of seed usually varies proportionately with quantity produced.

Slash pine seed are winged and generally disseminated by wind. Although some seed has been carried as far as 250 feet, more than 90 percent of the seed falls within 150 feet of its source. Where there is a prevailing wind direction of considerable force, seedfall may be sufficiently concentrated in one cardinal direction to influence cutting practices, but such occurrences are not common.

VEGETATIVE REPRODUCTION

Natural vegetative reproduction does not usually occur on slash pine, although young slash pine will on occasion sprout from the stump. Grafting and air-layering techniques, however, have been successfully developed.

The best method, "bottle grafting," utilizing dormant scions, brings about 75 percent success on potted as well as field-grown stock. During the growing season, the cleft-graft method with succulent material for both scion and rootstock has shown promise (19). Such cleft grafts form very strong, smooth unions.

Air-layering (rooting branches while they are still part of the tree) is also successfully used on slash pine (18). Air-layering young trees with 1.2-percent indolebutyric acid in July resulted in root development on 80 percent of the treated twigs. Air-layers have a balanced root system and develop rapidly.

SEEDLING DEVELOPMENT

Establishment

In a good seed year, slash pine often establishes reproduction of many thousand stems per acre. Seed viability is usually good (50 percent or higher) and germination occurs in about 15 days with adequate moisture, light, and heat.

Normal germination and establishment can be expected during a rather extended period from November to April following seed dispersal, and varies considerably with local weather conditions. New seedlings have been observed, however, after June rains following a dry spring. Germination and early survival are best on mineral soil, but slash pine seedlings can become established on almost any seedbed with fair success if other conditions are favorable.

Rodents, birds, insects, and diseases stand out among the many factors which limit the establishment of slash pine seedlings. Seed-eating mice (Peromyscus sp.), field rats, and birds have been a continual obstacle in any direct seeding program even though rodent poisons and repellents have been successful in certain instances. It is logical to assume, therefore, that these seed-eaters play an equally important part in the establishment of seedlings from natural seedfall.

Young slash pine seedlings, particularly planted stock, are sometimes attacked and killed by Pales weevil (Hylobius pales), an insect of increasing economic importance in the Southeast (14). On cutover pine lands, where these insects may be numerous, planting should be delayed at least a year after cutting or the planting stock should be dipped in a protective insecticide. Small seedlings may be defoliated and killed by the pine webworm (Tetralopha robustella), but in most instances the infestations are not fatal. Localized nematode infestations have been reported in some nursery stock; fumigation of seedbeds with ethylene dibromide prior to sowing is a recommended preventive.

Damping-off is a common disease of young slash pine seedlings, particularly nursery stock. Effective control can be achieved by applying $\frac{1}{2}$ fluid ounce of formaldehyde in 1 pint of water per square foot of bed 5 days prior to seed sowing (14). Damping-off is not serious where the nurseries are located in deep, well-drained acid soil. Late root rot is a major nursery disease of slash pine. It is thought to be caused by either a fungus or nematode activity, or both; the rot can usually be controlled by ethylene dibromide soil fumigation (13). Southern fusiform rust has been another serious nursery disease. Control requires weekly spraying with Bordeaux mixture or Fermate from March to June. Culling visibly infected seedlings at lifting time is also recommended.

Excessively high surface temperatures occasionally cause some loss in nursery stock, but frequent watering during hot, dry periods will usually keep losses to a minimum.

Natural seedling establishment is influenced more by seed production and dissemination than by all of the previously mentioned factors combined. If weather conditions are favorable, a good seed year will generally result in the production of an adequate seedling crop.

Early Growth

Under normal conditions, slash pine seedlings start rapid height growth soon after germination. There is no "grass-stage" like that in longleaf pine. Early growth may be retarded on poor sites and "sour land," but it is not unusual for a seedling on an average site to grow one foot in height during the first growing season.

Ground competition, consisting of saw-palmetto, gallberry, grass, and other plants, probably exerts considerable influence on the early growth and development of slash pine. Seedlings that are planted or come in naturally on

old fields grow rapidly in height and stem diameter in the absence of competing vegetation. Early growth is best on moist but well-drained sites. Sites underlain with hardpan result in reduced growth during periods of extreme moisture conditions, both wet and dry.

Seasonal height growth usually starts early in March and makes most of its advance in March, April, and May (5, 21). Several spurts may occur in one season, the first spurt being the greatest. Radial growth starts about the same time, but continues for a longer period. Although radial growth is generally completed before November, studies in north Florida have shown that some radial growth occurs between November and March.

On the very best sites, and with a minimum of competing vegetation, 5-year-old slash pines may reach a height of 20 feet. Under more normal conditions, however, the 5-year-old seedlings will average 10 feet in height. Stocking or spacing does not exert a significant effect on the height growth of even-aged slash pine seedlings (1). Height growth of slash pine plantations in Florida can be estimated from two easily measured properties of the soil profile (2): depth to a fine-textured horizon, and depth to a mottled horizon. An estimate of the site index of natural stands of slash pine can be made from the following subsoil texture classifications (7): sands and loamy sands, 75; sandy loam and sandy clay loam, 80; loam, clay loam, sandy clay, and light clay, 85; silt loam, silty clay loam, silty clay, and heavy clay, 90.

Early root growth is also extensive and may be responsible for considerable suppression of younger seedlings. Evidence from interplantings in south Georgia (3) indicates that a difference of only 1 year in the age of planted slash pine can result in suppression of the younger trees. After 8 years, the interplants were only 70 percent as tall and 54 percent as large in stem diameter as the original seedlings.

Slash pine seedlings are susceptible to fire injury and easily killed when they are small. A 6-foot tree can survive a cool backfire under the best of conditions, but will suffer some loss in diameter and height growth if any crown scorch is incurred. Studies have shown that prescribed burning should not be attempted in slash pine stands until the trees are at least 12 to 15 feet tall (11).

Seedlings and young trees often suffer from attacks of fusiform rust (Cronartium fusiforme) or pitch canker (Fusarium lateritium f. pini). The spread of the rust from the branches into the stems can be reduced by maintaining heavy stand densities, which encourage natural pruning. On sites with high fusiform rust hazard (e.g., where trees of rust-susceptible oak species are abundant), longleaf pine should be favored over slash pine. The black or red oaks are more susceptible than the white oaks. Pitch canker, the other common stem disease of slash pine, occurs commonly on trunks and branches of small trees and results in an abundant flow of gum and heavy pitch soaking of the wood.

Fomes annosus, a widely distributed root-killing fungus in both Europe and North America, has caused extensive damage to planted conifers in Europe. Recently, it has been reported as causing mortality in several slash pine stands in southeastern United States (6).

Bark beetles are capable of killing large volumes of slash pine. Three species of the pine engraver beetle, Ips avulsus, Ips calligraphus, and Ips grandicollis, cause considerable loss each year, but are usually most damaging during extended dry spells. Outbreaks are frequently associated with wildfires, wind, and ice storms, lightning-struck trees, and small logging operations.

The black turpentine beetle (Dendroctonus terebrans) has become an increasingly important killer of slash pine. Although this bark beetle has taken its heaviest toll in mature trees worked for naval stores around drought-affected pond margins and flatwoods, it is capable of breeding in stumps on cutover areas and eventually attacking residual round trees.

SAPLING STAGE TO MATURITY

Growth and Yield

Mean annual growth in cords on the best slash pine sites culminates at about 20 years of age, and falls off gradually thereafter. On one of the better sites on the Olustee Experimental Forest, near Lake City, Florida, a managed stand of slash pine has produced 60 cords of pulpwood per acre in 27 years, a mean annual production of 2.2 cords per acre (8).

Diameter growth is affected by site, age, and growing space; height growth is affected by site and age.

A study in south Georgia (4) showed that diameter growth was also affected by artificial pruning if the crown ratio was reduced to less than 50 percent. Pruning up to 80 percent of the live crown, however, had little or no effect on height growth of planted slash pine. Ordinarily, slash pine tends to prune itself naturally, particularly in dense stands. In plantations and medium-stocked forests, however, early artificial pruning may be economically sound because of increased yield from clear material.

On account of the great range in site throughout the slash pine belt (site index of 50 to 110 feet in height at 50 years), it is difficult to present average growth or volume estimates without including site classes (26). A large percent of all slash pine stands, however, fall in the 70- and 80-foot site index class. In a managed forest, yields differ materially from those given for normal stands; therefore, normal yield tables will not give reliable estimates for managed stands unless adjustments are made. The average diameter and volume per acre for several stands of varying age and density under management, site index 80, are as follows (17):

Age (Years)	Trees (Number)	Average d.b.h, 100 largest trees (Inches)	Cords (Number)
	210	3.8	--
8	385	3.6	--
	720	3.4	--
	170	9.4	13
18	325	8.6	18
	630	7.9	25
	170	10.2	17
23	240	9.4	24
	500	8.9	34

A graphic presentation of plantation growth in Florida (fig. 2) indicates that the culmination of mean annual growth occurs sooner on a good site than on a poor site. Stocking has very little influence on increment rates on poor sites, as indicated by the single line representing from 200 to 1000 trees for site index 60, but it becomes increasingly important on the better sites.

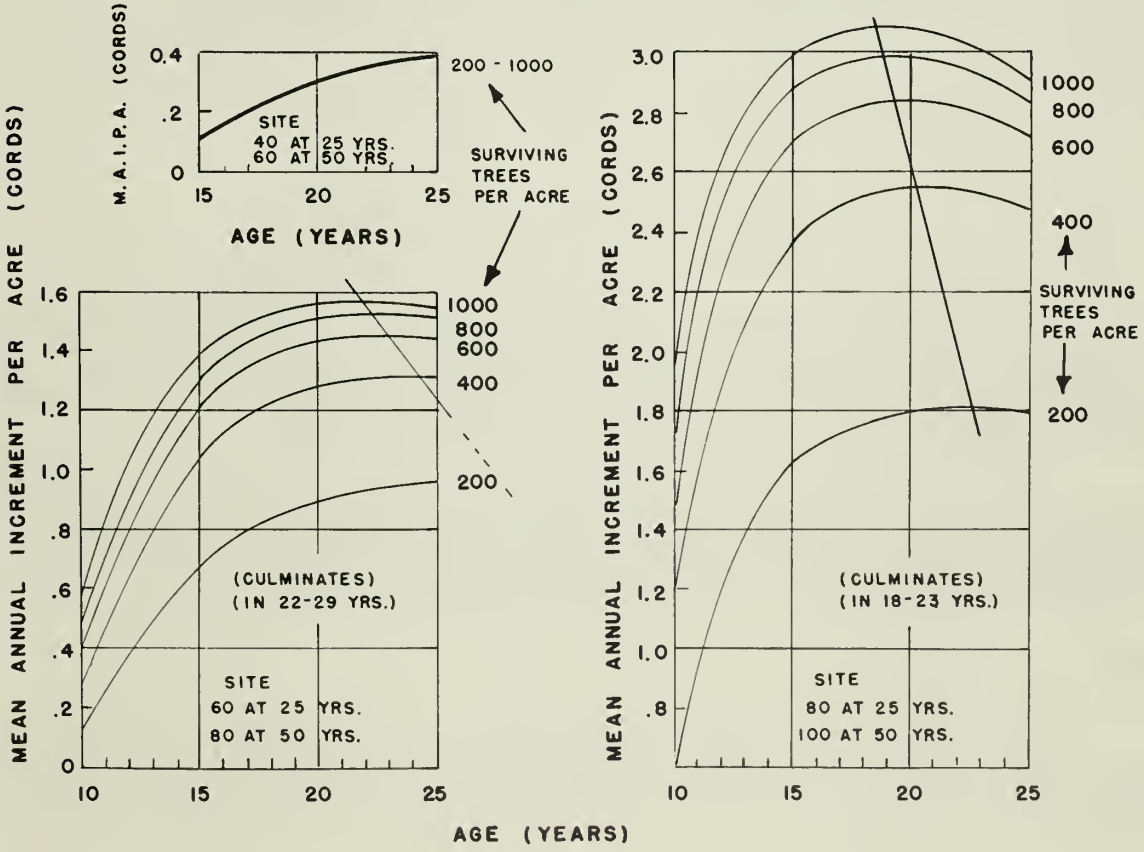

Figure 2.--Growth culmination of slash pine plantations in Florida, by W. G. Wahlenberg, after Barnes (1).

Average annual board-foot growth for site index 80 reaches its maximum at 50 years of age. Additional research is in progress to determine the growing stock needs for optimum production. For the present, however, a volume of 7 thousand board-feet (Scribner) per acre seems adequate for a 50-year rotation on an 80-foot site. Several fairly heavy thinnings will be necessary in a managed forest to maintain this volume.

Yields may be materially reduced by red heart (Fomes pini) or red-brown butt rot (Polyporus schweinitzii). Red heart is the most important decay-causing fungus in slash pine, particularly in mature and overmature trees.

Yields of gum from slash pine trees worked by bark chipping and acid treatment vary with a great number of factors. Studies have shown that large, fast-growing trees with big crowns have high gum yields (22), but some trees were found to run more gum than other trees of the same size and general appearance (20). The size of the radial resin ducts exposed by chipping, the number of resin ducts per square inch of fresh streak, and the viscosity of the gum have all been identified as factors which control gum flow.

Since tree diameter is probably the easiest characteristic to recognize in the field, the following gum-yield tabulation is presented for diameters from 9 to 14 inches, site index 70, and crown length of 35 percent (22).

Diameter at breast height (Inches)	Gum yield (Barrels per crop)
9	151
10	179
11	208
12	236
13	265
14	293

The tabulation represents a good average of naval stores stand conditions within the range of slash pine. Gum yield will decrease when crown-length is less than 35 percent and increase when it is above 35 percent. The yield probably increases on better sites and decreases on poorer sites.

Gum yields will also be affected by the occurrence of dry face and pitch streak, the latter a disorder often associated with the dry face condition. Slash pines growing on pond sites are particularly susceptible, and up to 50 or 75 percent of these trees are sometimes affected in varying degrees.

Reaction to Competition

Slash pine is intermediate in tolerance and can theoretically be managed either in all-aged or even-aged stands. It is more tolerant than longleaf pine. Even though slash pine seedlings lack longleaf's remarkable natural resistance to fire, they are invading longleaf stands, especially where cutover or poorly stocked land has been given some protection from fire.

In a dense even-aged stand of slash pine, the expression of dominance may be slow, and stagnation may result. Early thinnings are to be recommended in these instances. Under extreme conditions a precommercial thinning should be prescribed. This operation should reduce the number of stems to the point where there will be no need for further thinning before a commercial cut. Although young stands respond promptly to thinning, older stands or those in poor growing condition are often slow to respond, or occasionally fail to respond at all.

Because prescribed burning is recognized as a necessary tool of management in most slash pine stands and because this species is only moderately tolerant, even-aged management is generally favored over all-aged conditions. The use of fire for protection appears to be out of the question in all-aged stands because of the damage to young reproduction. Single-tree selections may open up holes large enough for new seedlings, but the trees will probably grow very slowly and develop suppressed characteristics.

Turpentining operations are most efficient in an even-aged forest because the faces can be concentrated. This same type of forest is also preferred where the invasion of undesirable hardwoods is a problem.

Competition from ground vegetation has been found to exert a considerable influence on the survival and growth of slash pine seedlings. This is particularly true with planted seedlings. The big difference in early height growth between trees on old-field and cutover areas is at least partially due to vegetative competition. Estimates have been made that old-field sites are from 5 to 10 feet higher in site quality than forest sites (1).

SPECIAL FEATURES

Slash pine was first recognized by Stephen Elliott in 1824, and is now named after him; however, he first thought it to be a variety of loblolly pine.

Only slash and longleaf pine have commercial value for naval stores, and because of its higher yields, more fluid gum, and less scrape, slash pine is the more important. Both gum and wood may be produced in the same stand by turpentining only the trees to be removed in the next thinning or harvest cutting. After a tree has been selected for a naval stores face, spiral gutters and aprons are attached with double-headed nails and a cup is placed below the apron to catch the gum. The rough outer and white inner bark are removed with a bark hack, making a 3/4-inch streak every 14 days from about March 15 to November 1. The freshly chipped streak is then sprayed with a 50-percent solution of sulfuric acid. All of the faced trees are harvested for sawlogs or pulpwood as soon as turpentining is complete (usually after 4 years for a single face or 8 years if back-faced), since bark beetles, turpentine borers, and fire can cause severe losses if worked-out trees are left standing. With this method, the entire butt log can be utilized with practically no waste.

RACES AND HYBRIDS

The nomenclature applied to slash pine has been a source of confusion for the past 100 years. Two distinct botanical species have been recognized and distinguished (16): Caribbean pine (Pinus caribeau Morelet), with tropical distribution in the West Indies and Central America, and slash pine (Pinus elliottii Engelm.), in the southeastern United States. In 1952, a variation of slash pine in southern Florida was officially recognized and named South Florida slash pine (Pinus elliottii Engelm. var. densa Little and Dorman). The term densa refers to the dense, heavy wood with very wide summerwood rings, to the grasslike seedlings with crowded needles, to the thick tap root, and to the thick hypoderm of the needles.

Limited trials in this country and in South Africa have not yet shown any distinct racial variation in growth rate of typical slash pine (9).

No natural hybrids of slash pine are known to exist, but it has been artificially crossed with both shortleaf pine (Pinus echinata) and loblolly pine (Pinus taeda) (10).

LITERATURE CITED

(1) Barnes, Robert L.
1955. Growth and yield of slash pine plantations in Florida. School of Forestry, Univ. Fla., Res. Rpt. 3, 23 pp., illus.

(2) _____ and Ralston, Charles W.
1955. Soil factors related to growth and yield of slash pine plantations. Univ. Fla., Agr. Expt. Sta. Bul. 559, 23 pp., illus.

(3) Bennett, Frank A.
1954. Reduction in growth of interplanted slash pine. U. S. Forest Serv. Southeast. Forest Expt. Sta. Research Note 55.

(4) _____
1955. The effect of pruning on the height and diameter growth of planted slash pine. Jour. Forestry 53: 636-638.

(5) _____
1956. Growth of slash pine plantations on the George Walton Experimental Forest. U. S. Forest Serv., Southeast. Forest Expt. Sta. Paper 66, 20 pp., illus.

(6) Campbell, W. A., and Hepting, G. H.
1954. Fomes annosus on slash pine. Plant Disease Reporter 38: 217.

(7) Coile, T. S.
1952. Soil and the growth of forests. Advances in Agronomy. 4: 329-398. illus.

(8) Cooper, Robert W.
1955. Slash pine maintains maximum growth after light precommercial thinning. The Unit 59: 26-27.

(9) Dorman, Keith W.
1952. Hereditary variation as the basis for selecting superior forest trees. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 15, 88 pp., illus.

(10) Duffield, J. W., and Righter, F. I.
1953. Annotated list of pine hybrids made at the Institute of Forest Genetics. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Research Notes 86, 9 pp.

(11) Gruschow, George F.
1952. Effect of winter burning on slash pine growth. Jour. Forestry 50: 515-517.

(12) Harrar, Elwood S., and Harrar, J. George
1946. Guide to southern trees. 712 pp., illus. New York.

(13) Henry, Berch W.
1953. A root rot of southern pine nursery seedlings and its control by soil fumigation. Phytopath. 43: 81-88.

(14) Jackson, L.W.R., Thompson, G. E., and Lund, H. O.
1955. Forest diseases and insects of Georgia's trees. Georgia Forestry Com. Bul., 40 pp., illus.

(15) Little, Elbert L., Jr.
1953. Check list of native and naturalized trees of the United States (including Alaska). U. S. Dept. Agr. Handbook 41, 472 pp.

(16) _____ and Dorman, Keith W.
1954. Slash pine (Pinus elliottii), including South Florida slash pine. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 36, 82 pp., illus.

(17) McCulley, R. D.
1950. Management of natural slash pine stands in the flatwoods of south Georgia and north Florida. U. S. Dept. Agr. Circ. 845, 57 pp., illus.

(18) Mergen, François
1955. Vegetative propagation of slash pine. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 54, 63 pp., illus.

(19) _____ and Rossoll, Harry
1954. How to root and graft slash pine. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 46, 22 pp., illus.

(20) Schopmeyer, Clifford S.
1953. The characteristics of a high-gum-yielding tree. U. S. Forest Serv. Southeast. Forest Expt. Sta. Research Note 39.

(21) _____
1955. Effects of turpentining on growth of slash pine: first-year results. Forest Sci. 1: 82-87, illus.

(22) _____ and Larson, Philip R.
1954. Gum-yield tables for slash and longleaf pine on poorer than average sites. U. S. Forest Serv. Southeast. Forest Expt. Sta. Research Note 69.

(23) Snow, A. G., Jr., Dorman, K. W., and Schopmeyer, C. S.
1943. Development stages of female strobili in slash pine. Jour. Forestry 41: 922-923.

(24) Society of American Foresters
1954. Forest cover types of North America (exclusive of Mexico). Soc. Amer. Foresters, 67 pp., illus. Washington, D. C.

(25) U. S. Department of Agriculture
1941. Climate and man. Agr. Yearbook 1941, 1248 pp., illus.

(26) U. S. Forest Service
1929. Volume, yield, and stand tables for second-growth southern pines. U. S. Dept. Agr. Misc. Pub. 50, 202 pp., illus.

(27) _____
1948. Woody-plant seed manual. U. S. Dept. Agr. Misc. Pub. 654, 416 pp., illus.

(28) Wakeley, Philip C.
1954. Planting the southern pine. U. S. Dept. Agr. Monog. 18, 233 pp., illus.

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